

## PROCESS RESEARCH AND DEVELOPMENT

JET PROPULSION LABORATORY

D. B. Bickler

## Processing Overview

- 1975 to 1985 progress in low cost processing has reached a plateau
- Current emphasis upon high efficiency
- New cell designs; will need process development

## Major Processing Categories

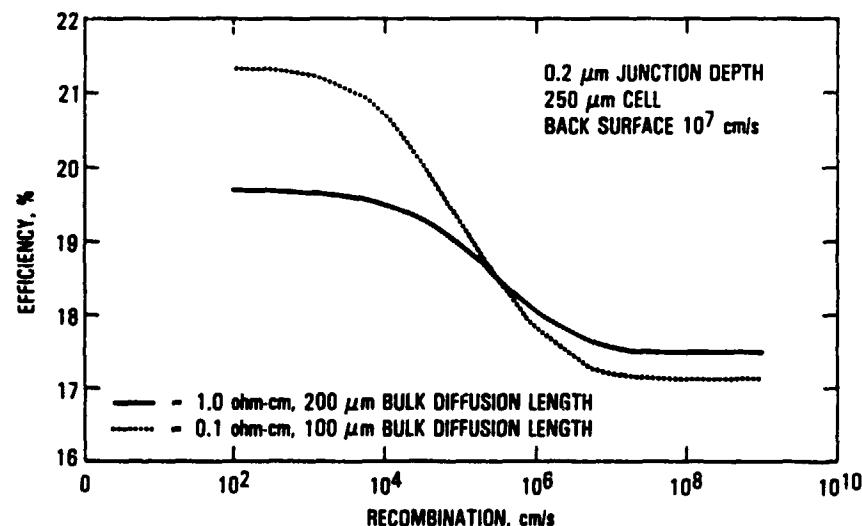
- Surface preparation: Damage removal etch  
Passivation  
A-R coat  
BSR
- Junction formation: Diffusion  
BSF  
Edge isolation
- Metallization: Front and back
- Assembly: Cell interconnection  
Encapsulation  
Framing  
Cable wiring
- Sequences: Relationships when combining individual processes

PRECEDING PAGE BLANK NOT FILMED

## Surface Preparation

| 1975                          | 1985                                   | Future                     |
|-------------------------------|--|----------------------------|
| Acid etch                     | Hydroxide etch                         | Hydroxide, then acid Etch  |
| Polymer anti-reflection (A/R) | Texture with polymer or dielectric A/R | A/R matched to passivation |
| \$1.22/W                      | \$0.20/W                               | \$0.10 to \$1.00/W         |

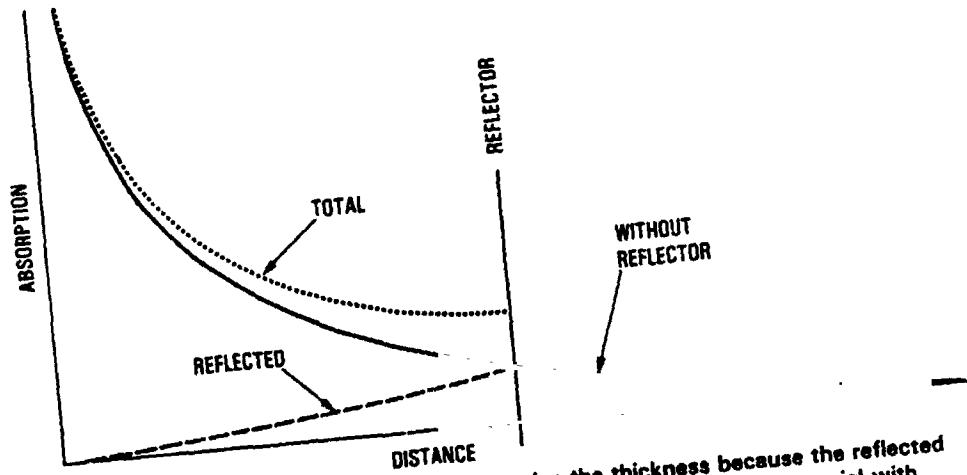
## Efficiency Versus Front Surface Recombination Velocity\*



When the front surface recombination velocity is brought below  $10^5$  cm/s, lower resistivity ( $0.1 \Omega\text{-cm}$ ) material outperforms  $1.0 \Omega\text{-cm}$  material even when the bulk diffusion length is less.

\*From E.I.H. Lin

## Back Surface Reflector (BSR)



The use of a BSR is better than a cell of twice the thickness because the reflected photons are absorbed nearer to the junction. This means that bulk material with lesser bulk diffusion length can be utilized efficiently.

## Junction Formation

| 1975                       | 1985              | Future                |
|----------------------------|-------------------|-----------------------|
| 0.4 $\mu\text{m}$ junction | 0.3 $\mu\text{m}$ | 0.2 $\mu\text{m}$     |
| Ohmic back                 | BSF               | BSR*                  |
| \$0.43/W                   | \$0.28/W          | \$0.15 to<br>\$1.00/W |

\* Not a junction process; requires surface passivation.

## PLENARY SESSIONS

### Metallization

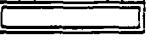
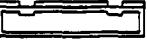
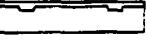
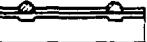
| 1975              | 1985                               | Future                 |
|-------------------|------------------------------------|------------------------|
| Mask and Ni plate | Screen print Ag                    | Laser writing plate up |
| Solder dip        |                                    |                        |
| Full back         | Aluminum back with solderable pads | Gridded back           |
| \$1.00/W          | \$0.30/W                           | \$0.10 to \$0.20/W     |

### Assembly

| 1975              | 1985              | Future             |
|-------------------|-------------------|--------------------|
| CZ                | CZ                | Ribbon             |
| PF = .6           | PF = .8           | PF = .9            |
| Interconnectors   | Redundant ribbons | Redundant ribbons  |
| Soldered          | Soldered          | Welded             |
| Potted in polymer | Bonded to glass   | Bonded to glass    |
| Metal back mount  | Frame mounted     | Framed in field    |
| \$5.28/W          | \$0.80/W          | \$0.05 to \$1.00/W |

## PLENARY SESSIONS

### Sequences

| 1975                     | 1985          | Future                        |   |
|--------------------------|---------------|-------------------------------|---|
| Acid etch                | Texture       | Acid etch                     |   |
| Diffuse                  | Diffuse       | Oxidize                       |   |
| Etch                     | BSF           | UV sk front                   |  |
| A-R coat                 | Clean         | Etch                          |  |
| Mask                     | Mask          | Diffuse                       |   |
| Etch                     | Edge etch     | Mask front                    |   |
| Plate                    | Print back    | Etch back and edge            |   |
| Clamp mask               | Print grid    | Etch front                    |  |
| Edge etch                | Fire          | Passivate front and back      |   |
| Solder dip               | A-R coat      | Align and mask front and back |  |
| Clean flux               | Test          | Etch                          |   |
| Test                     |               | Metallize front and back      |  |
| Hand solder interconnect | Ribbon solder | BSR                           |   |
| Clean flux               | Clean flux    | Test                          |   |
| Prime glass              | Bond glass    | Weld                          |   |
| Pot                      | Frame         | Bond glass                    |   |
| Frame                    | Test          | Frame                         |   |
| Test                     |               | Test                          |   |
| \$30.00/W*               | \$5.00/W*     | \$2.00 to \$10.00/W           |   |

\*With yield and profit.